

**CLAIMS**

1. An optical signals polarisation control method, comprising the steps of:

- 5       - feeding an optical input signal ( $S_{in}$ ) to a first polarisation transformation block (PC1) for providing a corresponding first optical output signal ( $S_1$ ),
- 10       - feeding the first optical output signal to a second polarisation transformation block (PC2) for providing a corresponding second output signal ( $S_{ou}$ ),

15       characterised by comprising the step of providing to said blocks regulating signals variables within limited operating intervals and such as to permit said blocks to assume the following alternative configurations:

- 20       - at least one configuration (A;D) wherein one block between the first and the second blocks assumes an active state in which it performs a polarisation transformation that is variable over time, and the other block assumes an inactive state in which it carries out a polarisation transformation that is substantially constant over
- 25       time,

- 30       - at least one additional configuration (B;C) wherein one block between the first and the second blocks is in the active state and the other block is in a reset state in order to carry out a rewind operation wherein at least one of the corresponding regulating signals is made to assume a value within the corresponding limited interval.

2. The method according to claim 1, wherein:

- said at least one configuration includes the following alternative configurations: a first configuration (A) wherein the first block assumes the active state and the second block assumes the inactive state, and a second configuration (D) wherein the first block assumes the inactive state and the second block assumes the active state;
- said at least one additional configuration includes the following alternative configurations: a second configuration (B) wherein the second block is in the active state and the first block in the reset state, and third configuration (C) wherein the first block (PC1) assumes the active state and the second block (PC2) assumes the reset state.

3. The method according to claim 1, wherein at least one of said first and second output signals has a polarisation state that is variable between all the possible states of polarisation.

4. The method according to claim 1, further comprising:

- a step of reaching a limit value by at least one regulating signal of one of said blocks;
- a step of generation of at least one regulating-reset signal for bringing one of said blocks, for which the reaching of the limit value has occurred, into the reset state.

5. The method according to claim 4, further

comprising the steps of:

- completing said rewind operation for one of said blocks which has assumed the reset state,
- generating at least one regulating-deactivation signal in order to bring one of said blocks from the reset state into the inactive state.

6. The method according to claim 1, comprising one of said steps:

- transforming the input signal into the second output signal by carrying out any-to-any type polarisation transformations;
- transforming the input signal into the second output signal by carrying out any-to-fix type polarisation transformations;
- transforming the input signal into the second output signal by carrying out fix-to-any type polarisation transformations;

7. The method according to claim 1, comprising the stages of:

- generating a feedback signal (Sfb) starting from the second output signal (Sou);
- processing said feedback signal and generating the regulating signals to be fed to said blocks.

8. The method according to claim 7, comprising a measurement step, carried out on the basis of an optical feedback signal (Sofb) which is dependent on said second output signal, the measurement step returning the feedback signal correlated with a quantity which is associated with the optical

feedback signal (Sofb).

5 9. The method according to claim 8, wherein said quantity is an optical power associated with the optical feedback signal, the method including a generation stage of the regulating signals in such a manner as to control said optical power.

10 10. The method according to claim 9, additionally comprising generation stages of the dithering type regulating signals for inducing variations in said polarisation transformations carried out by one of said blocks in the active state.

15 11. A polarisation controller device (50), comprising:

- a first adjustable block (PC1) for transforming the polarisation of an optical input signal (Sin) and providing a corresponding first optical output  
20 signal (S1),

- a second adjustable block (PC2) distinct from the first block (PC1), for receiving the first output signal as input and transforming its polarisation, thus providing a corresponding second optical output  
25 signal (Sou),

characterised by comprising a control stage (CB), for providing to said blocks regulating signals varying between limited operating intervals, adapted to bringing the device into the following  
30 alternative configurations:

- at least one configuration (A;D) wherein one block between said first and second blocks, assumes

46

an active state in which it performs a polarisation transformation that is variable over time, and the other block assumes an inactive state in which it carries out a polarisation transformation, that is substantially constant over time,

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- at least one additional configuration (B;C) wherein, one bloc between said first and the second blocks is in the active state and the other block is in a reset state wherein at least one of the corresponding regulating signals is induced by the control stage to assume a value within said limited interval.

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12. The device (50) according to claim 11, wherein:

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- said at least one configuration includes the following alternative configurations: a first configuration (A) wherein the first block assumes the active state and the second block assumes the inactive state, and a second configuration (D) wherein the first block assumes the inactive state and the second block assumes the active state;

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- said at least one additional configuration includes the following alternative configurations: a second configuration (B) wherein the second block is in the active state and the first block in the reset state, and third configuration (C) wherein the first block (PC1) assumes the active state and the second block (PC2) assumes the reset state.

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13. The device according to claim 11, wherein said blocks are such as to carry out polarisation transformations such that at least one out of said

first and second output signals has a polarisation that is variable between all the possible states of polarisation.

5           14. The device (50) according to claim 11, wherein said control stage (CB) is such as to generate at least one regulating-reset signal for bringing one of said blocks into the reset state following the reaching, by one of the corresponding regulating  
10           signals, of a limit value of its own operating interval.

          15. The device (50) according to claim 11, wherein at least one of said first and second blocks is  
15           realised according to one of the following typologies: any-to-any, fix-to-any, any-to-fix.

          16. The device (50) according to claim 15, wherein said first and said second blocks are of the any-to-  
20           any type, such that the first and the second blocks may accomplish any-to-any type overall polarisation transformations.

          17. The device (50) according to claim 15, wherein  
25           said first block is of the fix-to-any type and said second block is of the any-to-any type, in such a manner that the first and the second blocks may accomplish fix-to-any type overall polarisation transformations.

30           18. The device (50) according to claim 15, wherein said first block is of the any-to-any type and said

second block is of the any-to-fix type, in such a manner that the first and the second blocks may accomplish any-to-fix type overall polarisation transformations.

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19. The device (50) according to claim 11, wherein the first and the second blocks respectively, include, a first (PCa1, PCb1) and a second (PCa2, PCb2, PCc2) plurality of optical polarisation conversion elements.

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20. The device (50) according to claim 19, wherein said first and said second pluralities include at least one corresponding first optical element (PCa1; PCa2) having a fixed principal birefringence axis and a birefringence that is variable on the basis of a corresponding first regulating signal generated by said control stage (CB).

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21. The device (50) according to claim 20, wherein said at least first optical element is a fibre optic squeezer.

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22. The device (50) according to claim 20, wherein said at least first optical element, is a liquid crystal element.

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23. The device (50) according to claim 19, wherein at least one of said first and said second pluralities includes at least one second optical element (PCa1; PCa2) having fixed birefringence and having a principal birefringence axis that is

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variable on the basis of a corresponding second regulating signal generated by said control stage (CB).

5        24. A controlled polarisation system (100) comprising:

         - a polarisation controller device (50) realised according to at least one of the claims 11 to 23,  
         - a polarisation sensitive device (PSD) provided  
10        with:

         - an optical input port (3) for receiving the second output signal (Sou),

         - an optical output port (5) for making available an output signal (Sopt) having a  
15        polarisation state that is dependent on said second output signal;

         - an optical feedback port (4) for making available an optical feedback signal (Sofb) having a polarisation state which is dependent on said second  
20        output signal.

25. The system (100) according to claim 24, wherein said control stage (CB) includes a processing unit (PU), such as to process electrical signals obtained  
25        by from said optical feedback signal for generating the regulating signals.

26. The system (100) according to claim 25, further comprising a measuring device (MS) for receiving the  
30        optical feedback signal (Sofb), and providing an electrical feedback signal (Sfb) to be fed to the control stage, and correlated with a quantity



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associated with the optical feedback signal (Sofb).

5 27. The system (100) according to claim 26, wherein said quantity is the power associated with the optical feedback signal, and said control stage generates regulating signals in such a manner as to maximise the optical power of the emerging signal (Sopt) present over said optical output port (5).

10 28. The system (100) according to claim 26, wherein said measuring device includes a photo-detector (PHD) for converting the optical feedback signal (Sofb) into a corresponding electrical signal.

15 30. The system (100) according to claim 24, wherein said polarisation sensitive device (PSD) includes a polarisation beam splitter optically coupled to said optical input port (3) and having two outputs optically coupled to the optical output port (5) and  
20 to the optical feedback port (4).

31. The system (100) according to claim 24, wherein said polarisation sensitive device (PSD) includes a polariser which is optically coupled to the optical  
25 input port (3) and such as to transmit a selected part of the second output signal (Sou), having preset polarisation, over a corresponding output.

32. The system (100) according to claim 31, further  
30 comprising a first optical coupler, comprising a corresponding input such as to receive said selected part and send portion of it over a first output

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optically coupled to the optical feedback port (4), and a corresponding second output optically coupled to the optical output port (5).

5 33. The system (100) according to claim 24, such as to carry out coherent reception, and wherein said polarisation sensitive device (PSD) includes a second optical coupler (OC1) provided with:

- 10 - an additional input port in order to receive a local optical signal,
- a common output (G1) to which the local optical signal and the second output signal are sent, in such a manner as to obtain a resultant optical signal which is dependent on the state of
- 15 polarisation of said second output signal, said common output being optically coupled to the optical output port (5) and to the optical feedback port (4).

20 34. The system (100) according to claim 26, such as to perform compensation for polarisation mode dispersion and wherein said polarisation sensitive device includes a high birefringence fibre in which the second optical output signal is propagated, and

25 said measuring device (MS) includes a device which is able to provide an electrical feedback signal (Sofb) which is representative of the distortion of the second optical signal which is propagated within said fibre.

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